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Muskrats have their pleasures as do other animals, but as their favorite time for sport is after night, we have but little opportunity to become acquainted with them socially. On a warm quiet afternoon they appear to enjoy a sunning in some secluded spot. Their gambols in the water, of a quiet evening, remind me much of the playing of kittens. They may be seen at times, of a moonlight night, chasing each other over some sand bar near their watery home. On the whole a study of their enjoyments is very unsatisfactory, and much of our knowledge of the life history of these animals will be but slowly acquired.

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THE PROBLEM OF THE SOARING BIRD.

BY I. LANCASTER.

IT is now more than two years since I first made known the results of investigations on the methods of flight of the great soaring birds, carried on at intervals since 1850. The whooping cranes of the Northwest, performing their migrations on motionless wings, had at that early date fixed my attention, and my times of leisure down to 1876 were devoted to ransacking the scientific and literary world and to observing the birds in the act whenever it was possible to do so, that I might get an explanation of the phenomenon of more substantial character than mere guess-work. Plenty of assumed solutions were found scattered about. Such theologians as I consulted were confident that the question had reached its lowest terms when it was said that "God had created the birds to fly." Common-sense folks rejected the idea of fixed wings and held to a slow flapping that could not be seen, while the scientists were confident of upward slanting currents of air and various atmospheric disturbances which produced the result. Accounts of travelers as to the facts were hopelessly confused, with a single exception, that of Charles Darwin in his Naturalist's Voyage around the World. His solution of the matter, that of the surging head, was given provisionally.

I was not prepared to deny any of the solutions given and not more ready to admit them, being conscious of very much ignorance of the entire matter. Meanwhile my interest in the subject, constantly increasing, had, in 1876, overshadowed all others, and being disengaged from business, I devoted the ensuing five years to the birds on the Gulf coast of South Florida, where the soaring varieties were found in abundance, fully intending to unravel the case before leaving it. The task was a hard one, and the final solution was found in a totally unexpected direction. The predominant feeling I have since experienced in regard to it is one of surprise—surprise that in this ceaselessly active age mechanical possibilities of the most important character could exist in the atmospheric spaces all about us, with many of the largest species of existing birds putting them in daily practice before our eyes, and we still remaining completely ignorant of them! I propose in this paper to present, first, a few of the most significant facts exhibited by the soaring birds; next, to offer an explanation of the phenomenon; and finally, to examine the bearing of what has been said on the problem of artificial air-navigation.

I mean by a "soaring bird" one which habitually travels the air on motionless wings. All birds flap their pinions at times, and many of the smaller kinds, such as rooks, kestrels, crows and gulls can maintain flight on fixed wings when the conditions are favorable. But I would never think of observing them for lessons in soaring. They are too light to average the inequalities in the air current, and there are frequently long intervals of active wings before the fixed conditions occur. The soaring varieties are at it all the time. The frigate birds live in the air night and day for a week at a time without touching a roost. Their congeners, the buzzards, spend the day in the same style. The various cranes common to the coast often spend hours resting in the air, while the gannet is an admirable soaring bird with a heavy body and relatively small expanse of wings.

When I speak of "fixed" or "motionless" wings the meaning is that no muscular power is used to either overcome weight or air resistance. It is not meant that the pinions are absolutely rigid, like a board, for they are moved to accomplish change both in shape and position. But they do precisely resemble a board so far as the exertion of motive power is concerned. For instance, if a bird floats in a wind of unvarying velocity over any fixed point on the earth, then if a board of the same shape and size and weight were put in its place, it would remain there just as the bird does, as long as the conditions were unchanged. If the bird slightly changed the shape or position of its surfaces so as to vertically ascend indefinitely, the board would also ascend in the same way were it to be changed in a similar manner.

This is seen in the performances of what I have termed "effigies." They were surfaces of veneer or cardboard fastened to a frame and balanced by a weighted pendant. They would simulate the actions of "soaring" perfectly. I have made numbers of them. They would leave the hand and travel against the wind for as much as 500 yards, remaining up for fifteen minutes. They had no ability to automatically balance themselves in unsteady currents of air, but they were good illustrations of "soaring."

The first thing to be definitely ascertained was whether the wings of the soaring birds were in fact as motionless as they seemed. To determine this point demanded close inspection, and although the creatures were not fearful of man in that remote country, they preferred a distance of thirty to forty feet away. The captive bird was useless for any critical test. 'Tis true that a bird ten feet in alar dimensions, resting horizontally above one's head thirty feet away, with the clear sky as a background, could be pretty well examined; still a closer position was not only desirable but imperative, and a resort was had to the arts of mimicry with entire success. Procuring a few square yards of thin muslin fabric sufficient to completely envelope my person, it was covered with paint of the green and brown shades so as to resemble the tree tops of localities in the vicinity of either the breeding places or the roosts of the soaring birds, and barring the unpleasant sensation one has when engaged in the arts of gross deception, I had everything pretty much my own way. Some trouble was experienced in striking the happy mean of scaring the great creatures enough to keep them from alighting on my face, and still not frighten them away, as they were totally oblivious of my presence. Wing movements could now be studied in every conceivable position at leisure, endwise, sidewise, from above, from beneath, and at every sort of obliquity. The conclusions of observations made from the ground at thirty feet distance were confirmed from the tree-top stations at all distances, from twelve inches upwards. In the first Florida year, observations were made with good results about 150 times, during which all the varieties of soaring birds of 100 miles of coast line were viewed. The trees of the country are short and stunted, and easily climbed, and a little search was rewarded by the discovery of thick sturdy tops in which a secure lodgment could be had. The birds abounded in prodigious numbers, thousands occupying a single roosting ground. Not only was it seen that there was no motion of the wing as a whole, but that there was none of the individual feathers. There was no tremor, no slow nor fast waving; the entire bird moved when the wing did. When the wing was flapped there was no doubt about it, and the flapping could be seen as far almost as the bird was visible. Both the "soaring" and flapping were discoverable when they occurred beyond any doubt whatever. To determine horizontality of the sea breezes of the coast, a radial arm, feathered and balanced level, was used. It is evident that somewhere in the interior of the peninsula there must be an upward trend of the meeting winds from the Atlantic and Gulf, but there is none discoverable on the western coast. The wind, twenty-five feet above tide, moves uniformly on level lines, and ten feet above the forest tree tops no upward flow can be found. The lantern of Egmont light, 150 feet high, at the entrance of Tampa bay, was frequently used for these atmospheric observations.

There is a wide range in the relation between weight of bird and wing surface in the different species. It varies from less than one, to more than two feet for each pound weight. Uniformly the longer the wing to a given weight the greater the power of translation possessed by the bird, the man-of-war hawks in this respect surpassing all others. Wide, short wings were coupled with heavy bodies, as in the gannets, and these exhibited slower but steadier flight. The heavier the bird the steadier and easier seemed its movements, and a hungry vulture, which was very shaky in the breeze, could ride serenely when gorged with carrion.

The only peculiarities discoverable in the atmospheric condition required for soaring, was that the wind in all cases should move against the bird. The maximum velocity of this meeting of bird and air is unknown to me. I have timed the flight of frigate birds through calm air on fixed wings at 100 miles per hour, and their velocity seems to depend on their wishes more than on any limitation of the powers of translation. The minimum speed, however, can be approximated. For the frigate bird it is about two miles per hour, three for the buzzards and five for the gannets. The heavier the bird the greater is the minimum velocity required, and a gorged vulture cannot range itself with a flock of hungry ones, which are sporting in their minimum, without repeatedly flapping its wings.

(*To be continued.*)